APPENDIX A.   <u>GROUND LAUNCH SEQUENCER DESCRIPTION DOCUMENTATION (GLSDD)</u>

SECTION

GROUND LAUNCH SEQUENCER DESCRIPTION DOCUMENT (GLSDD)

A. INTRODUCTION

  1. PURPOSE

      The purpose of this document is to present the GLS
      Description Document, and the Definition Guide which
      defines the document's format. The GLS Description
      Document formulates the GLS Functional Requirements.
      These Requirements are the basis for development of the
      GLS Software Specification (KLO-82-0072) which defines
      the Implementation Techniques utilized to satisfy those
      requirements.

  2. SCOPE

      This document contains requirement details for the
      monitoring and sequencing activities of all Shuttle
      Integrated test, Checkout and Launch Countdown
      functions that require time critical sequencing of
      nominal and contingency functions.

  3. FORMAT REQUIREMENT

      The GLS Description Document (GLSDD) is used as an input
      file to a software utility which automatically
      generates most of the GLS software from the GLSDD. This
      utility assists in the development and maintenance of
      the GLS Software Set and requires the fixed format as it
      exists today. The Labels and Fields in the GLSDD are
      not only requirements but also directives to the
      Automatic Generation utility. Any changes to the GLSDD
      field definition may impact the Automatic Generation
      Utility.

B.   APPLICABLE DOCUMENTS

1.   SOURCE REQUIREMENTS

   (A)   Shuttle Launch Commit Criteria and Background
         (NSTS-16007)

   (B)   Operations Maintenance Requirement and
         Specification File II Volume I (NSTS-08171)

2.   REFERENCE DOCUMENTATION

   (A)   Level C Functional Subsystems Software
         Requirements (STS 83-0026)

   (B)   OFT LDB Software Interface Requirements
         (SS-P-0002-150)

   (C)   LO2/LH2/MPS/SSME/Software Application Set
         Requirements Document (KLO-82-0014)

   (D)   DPS Software Application Set Requirements
         Document (KLO-82-0059)

C. GROUND LAUNCH SEQUENCER (GLS) FUNCTIONAL DESCRIPTION

1. OVERVIEW

The GLS is a "Kennedy Delivered" fully Automated software set capable of performing Launch site common and unique functions. The software requires no operator action after initialization, except for unscheduled holds, failure dispositioning and contingency operations. All events of the GLS are scheduled by Countdown Time. Countdown activities will be suspended automatically for any requirement (i.e., LCC, OMRS) violations as defined in the GLSDD. Violations which occur after T-0/31 will result in a GLS "Breakout" and Safing will be automatically invoked.

2. GLS MAINLINE

This function provides the display and control of activities in the Terminal Countdown sequence. It manages the predetermined hold points (milestones) that reflect the status of all the GLS parameters. It also contains all holds and resume functions for the ground and on-board countdown clock.

3. BREAKOUT SAFING

In GLS Safing, the primary function is to stop the Redundant Set Launch Sequence (RSLS) and perform immediate critical tasks not handled by the ascent software. A mainline event complete indicator is maintained to track the progression of the Ground Launch Sequencer toward T-O. This indicator is then utilized by GLS Safing to determine the functions that must be performed. In addition to the GLS Mainline event complete indicator, the RSLS Abort Indication which is downlisted by the Vehicle will be used to determine any functions that must be performed if an SSME start sequence has been initiated.

The GLS event complete indication is documented in the Nomenclature Field of the GLSDD as a comment.

" $ GLS EVENT COMPLETE=XXX $ " or " $ GLS EVENT COMPLETE
is less than XXX " where XXX is the integer value
indicated.

There are currently no Safing Requirements Prior to T-9
minutes and counting.

D. GLSDD FIELD DEFINITIONS

1. SEQ - Sequencer Number. An assigned numerical identifier unique to each step which consists of a sequence group number followed by a sequence step number. Successive sequence numbers are in ascending order.

2. CDT/STEP - Countdown time (CDT). - Earliest time at which the step may be executed. For GLS mainline sequencing from T-9 minutes to T-0 the following rules apply: If the sequence encounters a CDT later than the permitted time, normal sequencing stops and a breakout will be automatically initiated. For times between -9 minutes and -1 minute, a 1 percent delta will be allotted before processing a breakout.

        COUNTDOWN TIME FORMAT: +/- M:SS or
                                  +/- SS.SS

    STEP - This field is also used to designate a unique branch label for GOTO statements.
    Branch Label Format: ST(NUMBER).

    STEP. In the sections identified by Sequence Numbers > 32767, this field may be assigned negative numerical identifiers unique to each step. This number will be used for realtime changes using the GLS Disk Files. The number must be negative to avoid collision with the mainline sequences.
    Negative Step Format: -XXXXX,

3. SITE - Specific site at which GLS sequence is performed.
    A - KSC Pad A unique requirement
    B - KSC Pad B unique requirement
    (BLANK) - Common to all sites

4. FUNC - Function. Defines the type of operation which is to be performed.

    TYPES:

    (A) ACL - Activate Control Logic. The reactive Control Limits for the indicated measurements are set to the specified limit if applicable. Reactive Control Logic for the measurement is

then activated. Subsequent failure of the measurement to meet these limits results in the measurement's Control Logic Sequence being executed.

(B) APL - Issue Analog Command. Issue analog command to the system under test. The value applied to the analog command will be specified in the single or low field.

(C) ------------- - Comment. A blank Function Field indicates the rest of the line is comment only. The comment is proceeded and ended with a dollar sign ($).

If the comment begins with a "$/////" then the function indicated is not performed by GLS and is provided for information only. The function is either performed by Cockpit Switch or the Redundant Set Launch Sequencer (indicated by (R/S)).

(D) CMD - Command. Issue command to GSE or the vehicle or pseudo command to CCMS CDBFR.

(E) CMLT - Command Multiple. Single LDB transaction that sends multiple commands (through consecutive channels).

(F) CMON - Continuous Monitor. This is a unique function which identifies the continuous monitoring of the RSS okay to Launch indicators which are used by RSS to request a Hold. This function is similar to the CVFY function but is implemented differently in the GLS software.

(G) COM - Communications Interrupts. An interrupt is sent via the FD specified, to the console indicated in the "single or low" field.

(H) CRSY - Change Responsible System (Console). The Function Designator's FEP responsible console for CCMS processing is changed as indicated.

(I) CVFY - Continuous Verify. This function continues to verify a parameter (see Item 7) at the measurement sample rate in parallel to the test sequence. Parameter limits (see Item 8)

are established at initialization. If the test
condition fails, the ELSE (see Item 9) option is
taken.

> **NOTE**: *All CVFY monitoring sets a Commit Criteria   Monitoring (CCM)
> flag for the Function Designator in the FEP which prevents the
> responsible Firing Room console from modifying GOAL Notifi-
> cation parameters for the specific FD. GLS will maintain con-
> trol of the GOALparameters until the end of the run and then
> return control back to the RSYS.*
>
> *In most cases CVFY's which occur after T-9/00 will establish
> limits when the sequence is encountered.*
>
> *The CVFYs in the Standalone Function, P006, are unique in
> that they do not set the CCM Flag as described above. The
> CCM Feature is only available at the GLS Backup Console.
> P006 processing will be handled by the GLS Mainline Console
> and therefore, requires a responsible console transfer to that
> console so that FEP interrupts can be managed and received.
> Because of this RSYS Transfer, all other systems will be unable
> to manipulate any of the P006 parameters.*

(J)   END - End of sequence or sequence routine.

(K)   ICL - Inhibit Control Logic. Reactive Control
      Logic (execution) for the indicated measurement
      is inhibited.

(L)   IGL - Inhibit GOAL Notification. Termination of
      the continuous verify/monitor function. Related
      to unique CMONs involving Clock Control rather
      than LCC monitoring.

(M)   ISSU - Issue Numerical Command. A numeric value
      issued via the LDB.

(N)   LABL - Label. Used to mark significant comments
      such as milestones, concurrent and contingency
      operations. (Directives used in Software
      Generation).

(O)   MMSG - Milestone Message. The text contained in
      the nomenclature field is the next milestone to
      occur and the time at which it scheduled.

(P)   MSG - Message. The text contained in the nomenclature field is the current function being performed in the sequence.

(Q)   OMSG - Operator Message. The text contained in the nomenclature field is to alert the GLS console operator of exceptions or required actions.

(R)   SUM - Summation. Sum all FDs for that sequence number and store the value in Sum x. Sum x is then verified to be between the Low and High limits specified.

(S)   VFY - Verify. One time test to determine if the measurement is within proper limits. Test failure always results in an ELSE action (see Item 9).

5.   DISC - Discipline. The RSYS that this function is related to.

6.   NOMENCLATURE - A 34 Character Test Description from the CCMS Data Bank.

7.   FUNCTION DESIGNATOR - A Function Designator from the CCMS Data Bank.

8.   VALUE:

(A)   SINGL/LO - Single value or low value of a low/ high range. No relational symbols are used. Format of LOW or SINGLE VALUE:

```
    State:  ON/OFF, OPEN/CLOSE, WET/DRY, TRUE/FALSE
  Analog:  Decimal Number
Digital
Pattern:  Xhhhh -  Hexadecimal
          Tttttt - Octal
          ddddd -  Decimal
          Bzzz  -  Binary
```

> ***NOTE:*** *When greater than or equal to, or less than or equal to notation is desired, use the following:*

```
                    VALUE
              LOW          HIGH
         -------------------------------
              QUAN         NOHI      For greater than or
                                       equal to QUAN.
              NOLO         QUAN      For LESS than or
                                       equal to QUAN.
```

    (B)   HIGH – High value for analog low/high range. No relational symbol is used. Same format as (A) above.

    (C)   An "FD" notation next to a LO or HIGH value parameter indicates a comparative measurement with the FD appearing on the following line.

    (D)   UNITS – CCMS Data Bank Engineering units. One to seven characters.

9.   ELSE – Action to take on test failure of a VFY or CVFY function:

    ELSE – Options are:

    (A) Voting Logic

        (1) OR – Denotes an alternative test follows. Any successful alternate test is sufficient. The alternate(s) follow in successive steps. An OR in one step indicates the next step is an alternate. The action to be taken upon test failure is listed at the end of the last step.

        (2) AND – Denotes an additional test follows. All tests must be successful. The additional test follows in successive steps. The step penalty is listed at the end of the last step.

(3) X of Y - A group of Y CVFY or VFY sequence
     items are tested. The sequence will
     continue if at least X items are successful,
     otherwise the last ELSE option in the group
     of Y will be executed.

(B) INHB Mxxx (Inhibit a milestone.) - Line items
     remain in effect until the time of the milestone
     is reached. Upon test failure, this option
     allows the sequence to continue, but places a
     constraint against the milestone identified by
     the Mxxx. When the Mxxx or any previously
     inhibited milestone is reached normal sequencing
     will stop and will enter the HOLD state. A
     parameter in the duration field identifies a
     nonstandard time at which a line is no longer
     valid.

     MILESTONE/LABELS

LABEL	FUNCTION	APPROX. CDT
M009	Go for T-9 Sequence	T-9 Min.
*M0AA	Orbiter Access Arm (Crew Access Arm) Retract Milestone	T-7 Min. 30 Sec.
MAPU	Orbiter APU Start Milestone	T-5 Min.
MPS4	Purge Sequence 4 Milestone.	T-4 Min.
*MLOX	ET LO2 Pressurizing Milestone	T-2 Min. 55 Sec.
*MLH2	ET LH2 Pressurizing Milestone.	T-1 Min. 57 Sec.
MSEQ	LPS Go for Auto Sequence Start (Redundant Set Launch Sequencer, RSLS) Milestone.	T-31 Sec.

LABEL	FUNCTION	APPROX.	CDT
**MENG	LPS Go for Main Engine Start Milestone	T-10 Sec.	
**MSRB	SRB Ignition Milestone	T-0 Sec.	

* Hold at these milestones only for items with "ELSE" equal to that specific milestone.

** After T-0/31 CDT, inhibits against these miletones results in an automatic breakout.

(C)   EXIT - Upon test failure, the normal sequence is immediately suspended. Breakout occurs and the safing routine is performed. A parameter in the duration field identifies the time at which the line item is no longer valid.

(D)   CPER - Upon test failure, a routine identified by the label is performed in parallel with the normal sequence. An added "TIL" or milestone statement identifies the time at which the line item is no longer valid.

(E)   GOTO - Upon test failure, branch to the step identified by the label.

(F)   SKIP STEP - Upon test failure, the next step will not be performed.

(G)   SKIP SEQ - Upon test failure, the next sequence group will not be performed.

(H)   LCC-1 - Launch Commit Criteria valid prior to T-9 Minutes. Failure of an LCC-1 item places a constraint against continuing past T-9 mintes. These measurements are FEP Interrupt monitored.

LCC-2 - Launch Commit Criteria valid until APU start. Failure of an LCC-2 item places a constraint against continuing past T-5 minutes. These measurements are FEP Interrupt monitored.

LCC-3 - Launch Commit Criteria valid until last hold point at T-31 Sec. Failure of an LCC-3 item places a constraint against continuing past T-31 Sec. These measurements are FEP interrupt monitored.

LCC-4 - Launch Commit Criteria valid until T-10 Seconds. Failure of an LCC-4 item places a constraint against continuing past T-31 seconds. A failure of an LCC-4 after T-31 seconds causes a breakout immediately. These measurements are FEP interrupt monitored.

NOTE: *LCC-X items in the GLSDD may not all be derived from the Launch Commit Criteria and Background Document (JSC-16007).*

(I)　HOLD - Upon test failure, holds the CDC.

(J)　DISPLAY - Upon test failure, display to the CRT the FD indicated.

(K)　WAIT/PROCEED - Upon test failure, delays processing and waits for an operator input to continue.

10.　DURATION - Specifies additional effectivity constraints to the "ELSE" action.

11.　*LCC REF. - Reference number of the LCC which addresses this requirement

12.　*OMRSD - OMRSD Requirement Number.

　* These fields are reference only, and not intended for close-loop tracking of requirement implementation.

E.   (GLS) OPERATIONAL NOTES:

1.   "Breakout" is defined as an automatic GLS software
     response to a condition which will not allow the
     terminal count to progress any closer to T-0 and
     must, therefore be recycled to a point of no closer
     than T-20 minutes from Launch. At breakout the GLS
     mainline program will be automatically suspended and
     a safing sequence will take its place.

2.   "Cutoff" is defined as a manually (PFPK) initiated
     command to the GLS software which will cause a GLS
     breakout.

3.   "Hold" as applied to the GLS is defined as that
     condition in which the countdown clock and
     progressive mainline sequencing stops, while the
     capability is retained to continue the countdown
     towards T-0 via a manual resume input from the
     Integration console PFPK.

4.   After T-31 seconds, all measurement failures
     annotated with "ELSE" action against MENG, MSRB, or
     LCC-4 will cause the sequencer to go immediately into
     a breakout sequence.

5.   At breakout, a remote communication (COM) interrupt
     will be sent to each subsystem console and will
     indicate that breakout has occurred. Other remote
     communication (COM) interrupts will be sent to
     indicate to the systems that the CCM Flags have
     changed back to the systems. A final remote com-
     munication (COM) interrupt is sent to indicate GLS
     Safing is complete.

6.   Those milestones defined in Section 4.9.B without a
     single or double asterisk are referred to as the GLS
     "Lookahead" milestones. Any voting logic failure
     that occurs prior to that failure's ending
     effectivity (defined in the failure's ELSE and
     Duration Fields) will result in a "Hold" at the first
     available Lookahead milestone that has not yet been
     reached by the GLS Mainline. This capability allows
     for the earliest possible recognition and subsequent
     resolution of a test failure.

F.   GLS CONTINGENCY AND CONCURRENTLY PERFORMED PROGRAMS

    G001   RSLS HOLD/ABORT INDICATION ROUTINE

    G002   SSME 1 LH2 PRE-VALVE PRESSURE RELIEF

    G003   SSME 2 LH2 PRE-VALVE PRESSURE RELIEF

    G004   SSME 3 LH2 PRE-VALVE PRESSURE RELIEF

    G006   REPLACE FAILED ET LH2 PRESSURE TRANSDUCER 1

    G007   REPLACE FAILED ET LH2 PRESSURE TRANSDUCER 2

    G008   REPLACE FAILED ET LH2 PRESSURE TRANSDUCER 3

    G009   RIGHT BI-POD HTR CHK

    G010   LEFT BI-POD HTR CHK

    G012   PASS FSM OR BFS GPC ERROR DECODE

    G013   TERMINATE ET LO2 REPLENISH

    G014   LOSS OF TACAN CHECK

    G015   BACKUP CONSOLE CRASH

    G016   RUDDER PEDAL TRACKING CHECK

    G017   LEFT RHC TRACKING CHECK

    G018   RIGHT RHC TRACKING CHECK

    G019   SRB HPU SHUTDOWN

    G020   H2 BURN SYSTEM PIC CAP VOLTAGE CVFY

    P001   AERO-SURFACE PROFILE EVALUATION

    P002   MPS GIMBLE PROFILE EVALUATION

    P003   SRB GIMBLE PROFILE EVALUATION

    P004   ET GO2 VENT ARM RETRACT

    P005   OAA RECONFIGURE FOR EXTEND AND HYD ACCUMULATOR
             RECHARGE

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P006        STANDALONE CVFY (EDO/SLAB/SHAB)

S012        MPS/SSME SAFING

S013        VENT DOOR MANAGEMENT
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G.   FIRING ROOM CONSOLE DISCIPLINES

FIELD ENTRY

APU	ORBITER AUX POWER UNIT
ARMS	ORBITER ACCESS ARM
BELE	SRB ELECTRICAL
BHYD	SRB HYDRAULICS
BINS	SRB INSTRUMENTATION
BPYR	SRB PYROS
BRS	SRB RANGE SAFETY
COMM	COMMUNICATION
DPS	FLT DATA PROCESSING SOFTWARE
ECLS	ENVIRONMENTAL CONTROL AND LIFE SUPPORT
EPDC	ELECTRICAL POWER DISTRIBUTION AND CONTROL
FCL	FLIGHT CONTROLS
FCP	FUEL CELL POWER
GNS	GUIDANCE AND NAVIGATION SYSTEMS
GOX	GOX ARM SYSTEMS
HYD	ORBITER HYDRAULICS
HYFU	HYPERGOLICS FUEL
HYOX	HYPERGOLICS OXIDIZER
INST	ORBITER INSTRUMENTATION
INTG	INTEGRATION
LH2	LIQUID HYDROGEN
LO2	LIQUID OXYGEN
MECH	ORBITER MECHANISMS

MPS   ORBITER MAIN PROPULSION SYSTEM

NAVA   NAVIGATION AIDS

PLINTG   PAYLOADS INTEGRATION

PVD   ORBITER PURGE, VENT AND DRAIN SYSTEMS

SLAB   SPACELAB

SHAB   SPACEHAB

SSME   SPACE SHUTTLE MAIN ENGINES

TINS   ET INSTRUMENTATION

TRS   ET RANGE SAFETY

WATR   SOUND SUPPRESSION WATER SYSTEMS